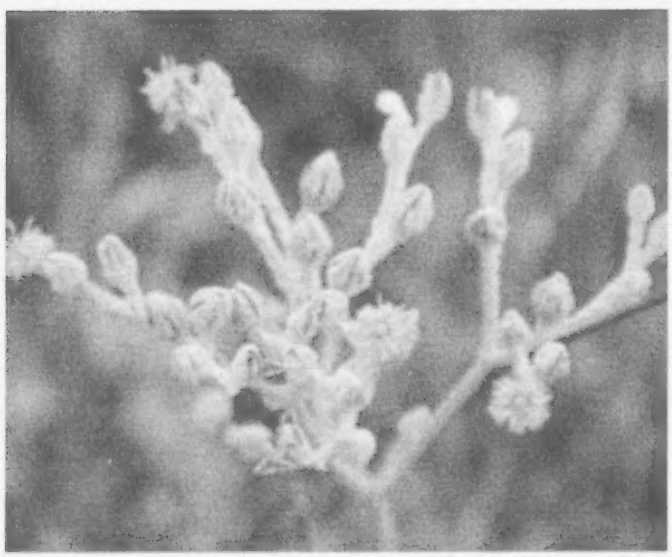
COSEWIC
Assessment and Status Report

on the

Goldencrest
Lophiola aurea

in Canada



SPECIAL CONCERN
2012

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Newell, R.E. 1999. Update COSEWIC status report on the golden crest *Lophiola aurea* in Canada, *in* COSEWIC assessment and update status report on the golden crest *Lophiola aurea* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-12 pp.

Keddy, C. 1987. COSEWIC status report on the golden crest *Lophiola aurea* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 26 pp.

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COSEWIC
Assessment Summary

Assessment Summary – May 2012

Common name
Goldencrest

Scientific name
Lophiola aurea

Status
Special Concern

Reason for designation
In Canada, this Atlantic Coastal Plain plant is found only in Nova Scotia at a few lake shores and wetlands. The Canadian population primarily reproduces vegetatively and is genetically distinct and geographically disjunct from the nearest populations in New Jersey 800 km to the south. Revisions to the COSEWIC assessment criteria since the species' last assessment account, in part, for the change in its risk status. Recent intensive surveys have also determined that the population is larger than previously thought. However, the species is subject to ongoing threats from development and habitat alteration.

Occurrence
Nova Scotia

Status history
Designated Threatened in April 1987. Status re-examined and confirmed in April 1999 and in May 2000. Status re-examined and designated Special Concern in May 2012.

COSEWIC
Executive Summary

Goldencrest
Lophiola aurea

Wildlife Species Description and Significance

Goldencrest (*Lophiola aurea*) is a perennial herb within the Bloodwort Family (Haemodoraceae). Plants arise from a rhizome with the erect, linear, blue-green leaves arranged predominantly in basal rosettes. Stems terminate in a single, densely white-woolly, branched inflorescence with yellow flowers that develop into round, many-seeded capsules.

Goldencrest is the only member of a distinctive genus and is globally uncommon with a very small range. It co-occurs in southern Nova Scotia with a large suite of other disjunct southern species of the Atlantic Coastal Plain, many of which are rare in Canada, including Redroot and Long's Bulrush. It is exceptionally disjunct among this suite of species, with Nova Scotia populations separated by 800+ km from the nearest known sites in New Jersey.

Distribution

Goldencrest is endemic to the Gulf and Atlantic Coastal Plains. In the United States, it is known from Louisiana to Georgia, North Carolina, Delaware (where it is extirpated), and New Jersey. In Canada, the nine populations (seven known extant) are restricted to two regions of southern Nova Scotia.

Habitat

In Canada, Goldencrest occurs on open lakeshores and graminoid-dominated peatlands. Low nutrient, acidic conditions prevail and disturbances such as flooding, wave action and ice scour prevent dominance of more competitive species. Lakeshore substrates are generally peaty, but often with only a thin organic layer over sand, gravel and cobble or bedrock. Elsewhere, the species is found on wet acidic soils in bogs, pocosins (freshwater wetlands with deep sandy and peaty soils), wet savannahs, pine barrens and sometimes in nearby anthropogenically disturbed habitats such as roadside ditches.

Biology

Goldencrest spreads extensively through rhizome and stolon growth. In Canada, it flowers in August and September. Seed banking is not documented but is plausible given the fluctuating lakeshore habitat in which the species occurs. Seedlings have not been observed in Canada, although little effort has been made to find them. Generation time is estimated at 3-5 years based on field observations suggesting vegetatively derived rosettes likely require several years before being capable of reproducing vegetatively. Individual clones appear very long-lived, potentially on the scale of decades.

Population Sizes and Trends

The total Canadian population includes hundreds of thousands of rosettes, although the number of genetic individuals is certainly much lower. Populations at Ponhook Lake (including Little Ponhook Lake) and Shingle Lake include about 93% of the ~75 known locations. Populations on these lakes are almost certainly slowly declining with shoreline development. Many of the several hundred cottages and residences on their shores have been built in the last 15 years. Shoreline development currently occupies no more than about 6% of shorelines on these lakes, and has likely reduced populations by less than 6% because development does not necessarily eliminate individual occurrences.

Other extant populations are relatively unthreatened and their populations have probably been stable in the past 15 years, although major declines from historical impacts are documented at Tiddville. The population at Brier Island has not been seen since 1985 and is presumed extirpated because of habitat change. The population at Sandy Cove, last documented in 1949, may be extant, but no subsequent searches are documented.

Threats and Limiting Factors

Shoreline development is the most serious threat to Goldencrest populations. The threat of shoreline development has been mitigated somewhat by the creation of a provincial nature reserve.

Other potential future threats are eutrophication, invasive species and peat mining. Historical impacts that are not current threats include water level management through damming of lakes and drainage of peatlands, diatomaceous earth mining, and off-road vehicle disturbance.

Protection, Status, and Ranks

In 2000, Goldencrest was listed as Threatened under the federal *Species at Risk Act* and the *Nova Scotia Endangered Species Act*. It bears a NatureServe rank of Apparently Secure (G4) globally. In Nova Scotia and Canada, Goldencrest is ranked as Imperilled (S2 and N2) with a General Status rank of At Risk, or "Red" under the Nova Scotia Department of Natural Resources' provincial ranks. In the United States, it is Apparently Secure (N4?), being known from seven states, in five of which it is rare or extirpated.

About 25% of the Ponhook Lake occurrences are on Crown land within Ponhook Lake Nature Reserve (representing ~10% of the Canadian population), granting them protection under the provincial *Special Places Protection Act*. Likewise, roughly 25% of sites on Shingle Lake are on Crown land and not available for development (representing an additional 10% of the Canadian population).

TECHNICAL SUMMARY

Lophiola aurea
Goldencrest Lophiolie dorée
Range of occurrence in Canada (province/territory/ocean): Nova Scotia

Demographic Information

Generation time (usually average age of parents in the population) *Field observations suggest time required for a new rosette to reproduce vegetatively exceeds one year (see Life Cycle and Reproduction).*	Unknown; perhaps 3-5 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? *Small decline inferred from impacts of shoreline development*	Yes
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations] *Existing shoreline development on the largest and most impacted population is estimated to have reduced numbers there by less than 6%. New shoreline development within the next 10 years at all sites will likely be much less than existing development, so total impacts expected over next 10 years likely to be less than 6%.*	<6% decline
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations]. *Existing shoreline development (probably not more than 50% of which has been within last 15 years) estimated to have impacted total population by less than 6% (see above).*	<6% decline
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations]. *New shoreline development within 15 years is projected to be much less than the existing development, which is estimated to have impacted total population by less than 6% (see above).*	<<6% decline
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future. *See above.*	<6% decline
Are the causes of the decline clearly reversible and understood and ceased? *Not readily reversible. Understood but not ceased.*	No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence *Extant sites only: 3000 km²* *Extant & historical (potentially extant) sites: 3330 km²* *All sites (including historical & extirpated): 4300 km²*	3330 km²
Index of area of occupancy (IAO) – 2 x 2 km grid *Historical (8 km²) but possibly extant occurrences included in this total. Including the extirpated site would add 4 km²*	104 km²

Is the total population severely fragmented?	No
Number of "locations*" *~75 locations if defined by land ownership. The number of locations is clearly greater than 10 (threshold value for COSEWIC's B criterion).*	>10
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy? *Small ongoing declines are not expected to reduce number of 2 x 2 km grid squares occupied.*	No
Is there an [observed, inferred, or projected] continuing decline in number of populations?	No
Is there an [observed, inferred, or projected] continuing decline in number of locations? *No losses definitively documented but recent past and future declines likely due to ongoing lakeshore development.*	Minor declines likely
Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat? *Ongoing lakeshore development observed to be causing declines in area, extent & quality of habitat, but a limited proportion affected at present.*	Yes
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Population	N Mature Individuals
Ponhook Lake (including Bear Trap & Little Ponhook lakes)	likely 100 000+
Hog Lake	~35
Shingle Lake	likely 100 000+
Seven Mile Lake	~215
Fancy Lake	100 000s
Dunraven Bog	1 000s
Tiddville Bogs	unknown (2750 flowering stems)
Total	>300,000

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not done

Threats (actual or imminent, to populations or habitats)

Shoreline development associated with cottage, residential and recreational waterfront development
Other threats not imminent at present

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? *USA: Apparently secure (N4?). Only known from seven states, extirpated in one and rare in four: Delaware (SX), Georgia (S1?), North Carolina (S2). Louisiana (S2S3), Alabama (S3S4), Mississippi (S4?), New Jersey (S4), Florida (SNR)*	
Is immigration known or possible?	Highly unlikely

* See definition of location.

Would immigrants be adapted to survive in Canada? *Canadian populations 800+ km disjunct from NJ, so some climatic difference. Morphological & genetic differences documented between Canadian & NJ populations.*	Possibly
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely?	No

Current Status

COSEWIC: Special Concern (May 2012)

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Special Concern	Not applicable
Reasons for designation: In Canada, this Atlantic Coastal Plain plant is found only in Nova Scotia at a few lake shores and wetlands. The Canadian population primarily reproduces vegetatively and is genetically distinct and geographically disjunct from the nearest populations in New Jersey 800 km to the south. Revisions to the COSEWIC assessment criteria since the species' last assessment account, in part, for the change in its risk status. Recent intensive surveys have also determined that the population is larger than previously thought. However, the species is subject to ongoing threats from development and habitat alteration.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. There are no long-term trend data; however, the size of the populations has likely decreased by <6% which is below criterion thresholds.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Although it meets Endangered for B1 and B2 and subcriterion b(iii) as the EO is <5000 km^2 and IAO is <500 km^2, and habitat quality and extent are declining, populations are not severely fragmented, there are >10 locations, and the population is not subject to extreme fluctuations.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. There are >>10,000 individuals in the Canadian population.
Criterion D (Very Small or Restricted Total Population): Not applicable. The number of individuals, IAO, and the number of locations exceeds thresholds.
Criterion E (Quantitative Analysis): No quantitative analyses available.

PREFACE

Since the previous status report (Newell 1999), there has been extensive fieldwork documenting many more sites, and individuals on lakes with previously known occurrences. One additional population was found within a separate watershed. An historical (1949) population at Sandy Cove on Digby Neck was not documented in the previous report but is listed in this update. Extensive fieldwork has failed to document the species' presence from a large number of lakes and peatlands in the vicinity of known records in Lunenburg and Queens counties, confirming that it is a very rare species in Nova Scotia. The Brier Island population is now considered extirpated, having not been seen since 1985, with the habitat at this site apparently becoming unsuitable through the combined effects of nutrient enrichment by nesting gulls and past drainage ditching. New conservation lands have been designated, protecting about 25% of known Ponhook Lake occurrences (though likely a lower proportion of individuals) at the Ponhook Lake Nature Reserve.

A recent study (Merckx *et al.* 2008) found morphological and genetic divergence between Canadian populations and the nearest populations to the south in New Jersey, although not necessarily of a magnitude that would warrant distinguishing Canadian plants as a separate species as was suggested by Fernald (1950).

A recovery strategy and management plan for multiple species of the Atlantic Coastal Plain, including Goldencrest, has been developed (Environment Canada and Parks Canada Agency 2010).

Different interpretations of the terms "mature individuals" and "locations" between this update and the previous status report produce significant differences in certain values relevant for assessing status. These are described in the report. There have also been changes in the nature of the thresholds for Criterion D (Very small or restricted total Canadian population) and a different interpretation of the concept of area of occupancy. These changes disqualify Goldencrest as threatened based on the criteria.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2012)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment Canada / Environnement Canada
Canadian Wildlife Service / Service canadien de la faune
Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

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2012

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Scientific Name: *Lophiola aurea* Ker-Gawl.

Original Description: J. B. Ker, 1813

Synonyms: *Lophiola americana* (Pursh) Wood
Lophiola septentrionalis Fern
Lophiola floridana Gandoger
Lophiola breviflora Gandoger

English vernacular name: Goldencrest

French vernacular name: Lophiolie dorée

Genus: *Lophiola*

Family: Haemodoraceae (see comments on family affinity below)

Order: Liliales

Class: Liliopsida

Major plant group: Angiosperms, Eudicotyledons

The eastern North American genus *Lophiola* contains a single species, *L. aurea*, and was described in 1813 by J.B. Ker (Maas and Maas-van de Kamer 1993). This report follows the Flora of North America treatment (Robertson 2002) in retaining Goldencrest within the Bloodwort family (Haemodoraceae), although Robertson (2002) does note recent research suggesting the genus is quite different from the remainder of that family, and may be better placed in Liliaceae subfamily Melanthioideae (Ambrose 1985), Tecophilaeaceae (Dahlgren *et al.* 1985), or Nartheciaceae (Zomlefer 1997). Zavada *et al.* (1983), Simpson (1988, 1990) and Dora and Edwards (1991) offer additional insight into the affinities of *Lophiola* with the broadly defined Lily family.

Fernald (1921, 1950) recognized three species of *Lophiola*: *L. aurea* in the southeastern United States, *L. americana* in New Jersey and Delaware, and *L. septentrionalis* in Nova Scotia, but recent treatments (*e.g.* Gleason and Cronquist 1991; Robertson 2002) include all three taxa in *L. aurea*, although Merckx *et al.* (2008) identified minor morphological and genetic differences between Canadian and New Jersey specimens. Goldencrest has a chromosome number of 2n = 42 (Ornduff 1979; Lowry *et al.* 1987).

Morphological Description

The following description has been derived from Gleason and Cronquist (1991), Robertson (2002) and Geerinck (1969). Figure 1 illustrates the species in its natural habitat as well as its general habit and inflorescence.

Figure 1. Goldencrest (*Lophiola aurea*) in a peaty shoreline meadow. Several vegetative plants (rosettes of blue-green strap-shaped leaves) are visible in the foreground. Inset shows a white-woolly inflorescence with flowers at anthesis. Photographs by Sean Blaney and David Mazerolle (inset), AC CDC.

Goldencrest is a perennial herb 30 to 85 cm in height with stems arising from a slender to thickened, somewhat stoloniferous rhizome. Stems are slender, glabrous to thinly hairy below becoming densely white-woolly above. Vegetative plants consist solely of basal leaf rosettes with linear leaves. Stems terminate in a single, densely white-tomentose and freely branched corymbose panicle, rounded to low-pyramidal in outline. The name *Lophiola* is derived from the Greek *lophia*, meaning crest or mane, referring to the showy pubescence on the inner side of the tepals. The fruit is a sub-globose, many-seeded capsule.

Morphological and genetic variability have not been investigated within Canadian populations, but Merckx *et al.* (2008) found minor morphological (doughnut-shaped vs. spherical orbicules on the anther locule wall) and genetic (minor DNA sequence differences in three non-coding DNA regions) differences between Nova Scotia and Florida populations. They considered these "not a convincing indication for delineation of two species", noting further work would be needed to clarify *Lophiola* taxonomy. Fernald (1950) split the species into up to three taxa, with Canadian plants separated as *Lophiola septentrionalis*, noting that many Nova Scotian plants are "large, freely stoloniferous and subcespitose" whereas typical New Jersey plants are small with solitary stems, short pedicels and a denser lanate tomentum".

The tall, white-woolly stems of reproductive Goldencrest are very distinctive, even when not in bloom, and can often be detected from a considerable distance. In this state, the species is unmistakable for any other species within its Canadian range. The basal leaf rosettes of vegetative individuals, which often form the bulk of populations, are much less conspicuous and can be overlooked even when present in large numbers. In its vegetative form, Goldencrest bears some resemblance to other basal rosette-forming species such as Blue Flag Iris (*Iris versicolor*) and Yellow-eyed Grass (*Xyris difformis*) and is most easily mistaken for Redroot (*Lachnanthes caroliniana*). It can be distinguished vegetatively from Redroot by its blue-green leaves and pale white roots.

Population Spatial Structure and Variability

The Canadian population occurs in two distinct regions within southwestern Nova Scotia (see *Canadian Range*): 1) Queens County and southwest Lunenburg County in a 50 km x 42 km area on lakeshores and two open peatlands in four different watersheds; and 2) in a much smaller area along the Bay of Fundy in eastern Digby County with known extant populations limited to a 3.5 km series of open peatlands. The two regions are separated by approximately 90 km. Given this separation, and the species' presumed limited dispersal potential, propagule exchange between these two regions and between sites within regions but in different watersheds is likely very infrequent.

Goldencrest is not severely fragmented because five of seven extant populations, representing almost all Canadian individuals, are large and are assumed to have good long-term viability. The Hog and Seven Mile lakes populations are likely stable as there are no obvious threats or disturbances, but may have lower long-term viability because of small numbers of individuals.

Designatable Units

Goldencrest occurs in two areas of southern Nova Scotia separated by 90 km. However, because there is no evidence of the distinctness of different Canadian populations and the species is restricted to a small portion of the COSEWIC Atlantic Ecological Area in southwestern Nova Scotia, Canadian populations should be considered a single designatable unit.

Special Significance

Goldencrest is a globally uncommon species in a monotypic genus with a restricted range. It co-occurs in southern Nova Scotia with a large suite of other disjunct southern species of the Atlantic Coastal Plain, many of which are rare in Canada, including the Special Concern Redroot and Long's Bulrush (*Scirpus longii*). It is exceptionally disjunct among this suite of species, with Nova Scotia populations separated by 800+ km from the nearest sites in Ocean County, New Jersey. The effects of genetic drift and natural selection in such isolated and peripheral situations can produce genetic, ecological, and morphological divergence, potentially giving populations a disproportionate significance to the species as a whole (Lesica and Allendorf 1995; Garcia-Ramos and Kirkpatrick 1997; Eckert *et al.* 2008). There is evidence that Canadian plants are morphologically and genetically differentiated from those in New Jersey and Florida (Merckx *et al.* 2008) and they have been considered a separate species in the past (Fernald 1950). No evidence of local aboriginal traditional knowledge on this species was found during the preparation of this report.

DISTRIBUTION

Global Range

Goldencrest occurs between 29° 40'N and 44° 30'N latitude and between 93° 33'W and 64° 32'W longitude (Figure 2). It is entirely restricted to the Gulf of Mexico and Atlantic Coastal Plains, occurring in a series of significantly disjunct regions. The Gulf of Mexico region is the largest of these, extending from Louisiana to southwest Georgia. Smaller disjunct occurrences are along the eastern seaboard in North Carolina, New Jersey, Delaware (where now considered extirpated) and Nova Scotia at the species' northern and eastern limit. Canadian occurrences, by far the most isolated within the species' global range, are restricted to small regions in southwestern Nova Scotia over 800 km northeast of the nearest occurrences in New Jersey's Ocean County.

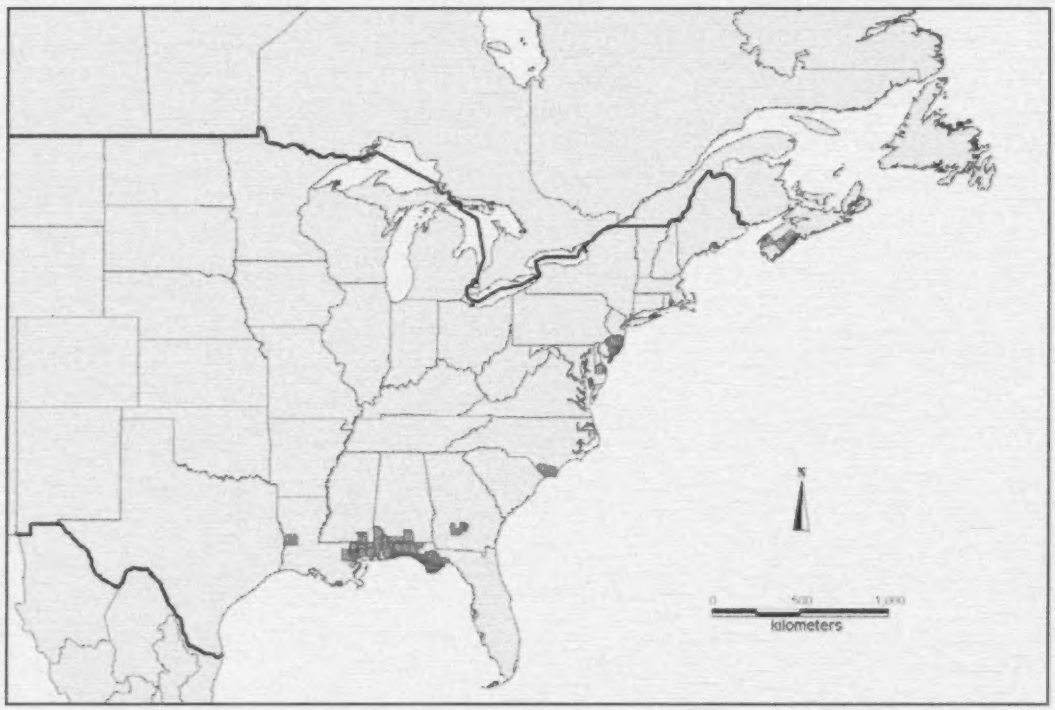

Figure 2. Global range of Goldencrest (*Lophiola aurea*), as illustrated by county-level distribution in the United States and Canada (modified from Kartesz 2010).

Canadian Range

In Canada, Goldencrest is restricted to two small regions in southwestern Nova Scotia (Figure 3). Known populations are found between latitudes of 44° 04'N and 44° 30'N and between longitudes of 66° 22'W and 64° 34'W, a 50 km by 144 km area.

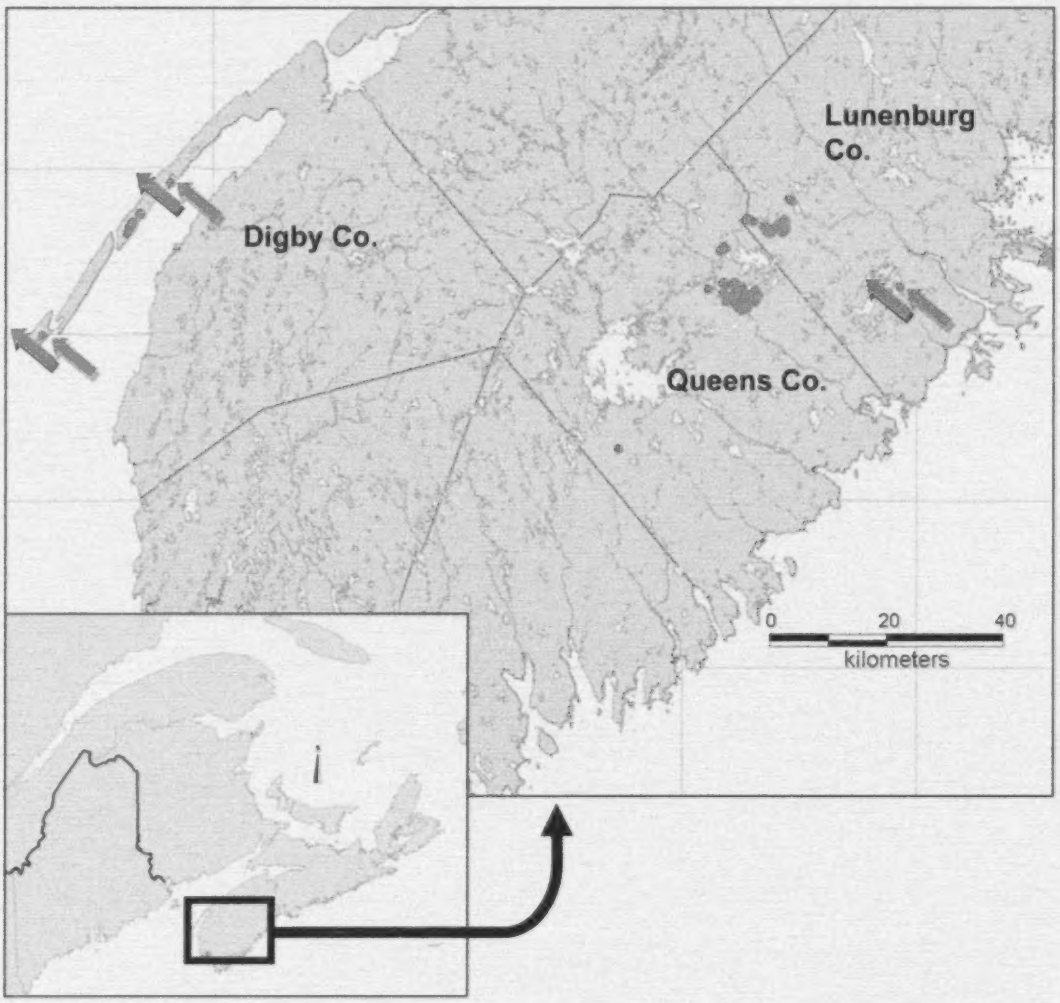

Figure 3. Canadian range of Goldencrest (*Lophiola aurea*). Arrows indicate presumed or potentially extirpated sites (see Figures 4 and 5).

The largest region of occurrence, supporting most of the Canadian population, is in the Southwest Nova Scotia Uplands Ecoregion (Webb and Marshall 1999) in Queens and Lunenburg counties (Figure 4). Goldencrest occurrences in this area are concentrated near the county border on Ponhook Lake (including Little Ponhook and Bear Trap lakes), Hog and Shingle lakes in the Medway River watershed, Seven Mile Lake in the LaHave River watershed and Fancy Lake in the Petite Rivière Watershed. Dunraven Bog supports an outlying occurrence approximately 30 km southwest of Ponhook Lake in the Mersey River watershed.

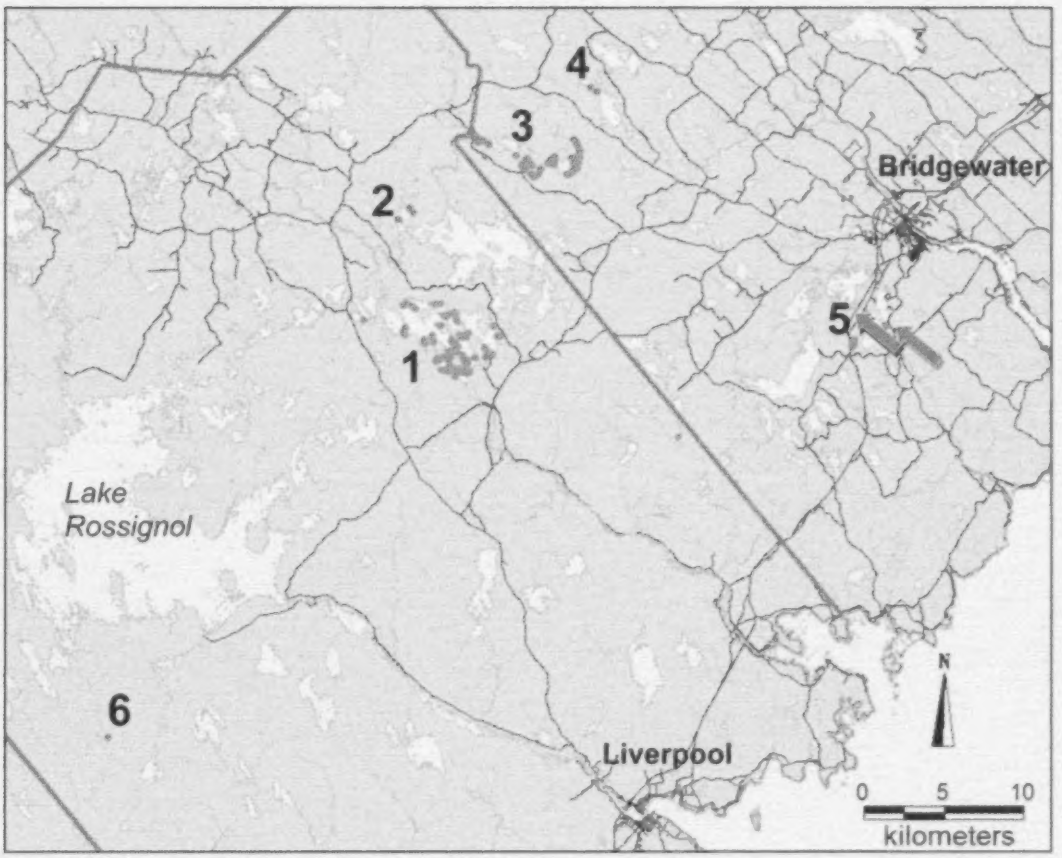

Figure 4. Distribution of Goldencrest (*Lophiola aurea*) in the Queens County and Lunenburg County region of occurrence. Population numbering is as follows: 1) Ponhook Lake and Beartrap Lake, 2) Hog Lake, 3) Shingle Lake, 4) Seven Mile Lake, 5) Fancy Lake (eastern location, indicated by an arrow, is historical with given location potentially in error) and 6) Dunraven Bog.

A second group of occurrences is found 90 km west along the coast of Digby County in the Fundy Coast Ecoregion (Webb and Marshall 1999; Figure 5). Populations there have been recorded in open peatlands near the Bay of Fundy within a 35 km zone between Brier Island and Sandy Cove on Digby Neck. The Brier Island population is believed to be extirpated and the Sandy Cove population has not been seen since 1949 and may also be extirpated, leaving only one population spread through a series of hydrologically connected peatlands over 3.5 km between Tiddville and East Ferry.

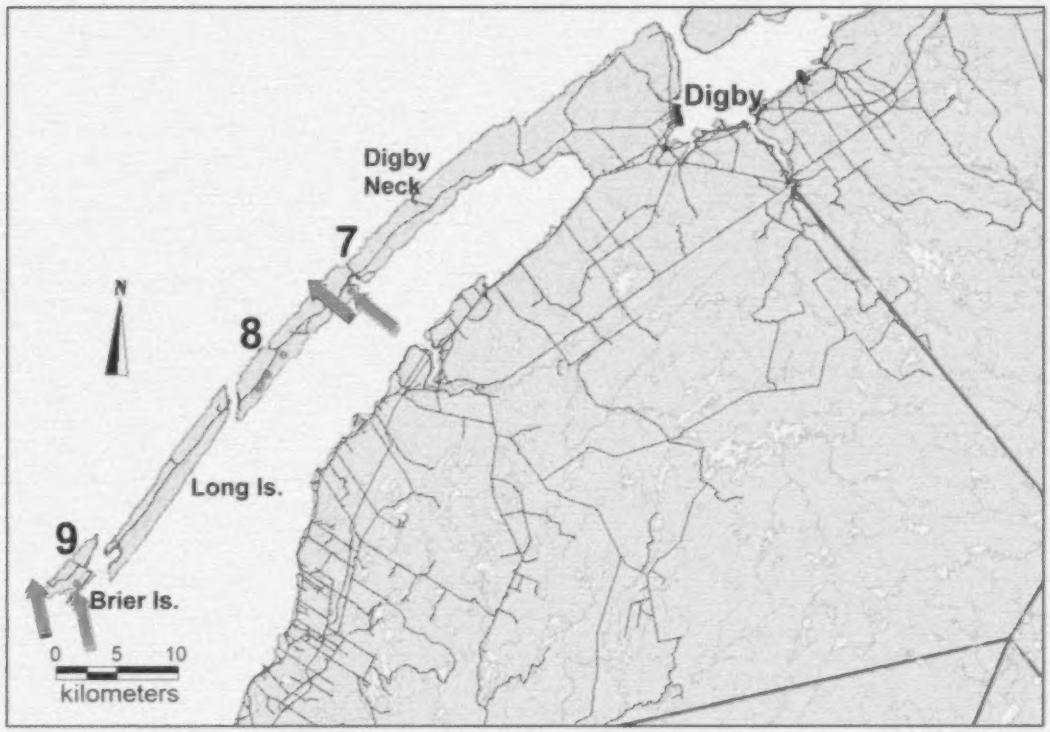

Figure 5. Distribution of Goldencrest (*Lophiola aurea*) in the Digby County region of occurrence. Population numbering is as follows: 7) Sandy Cove (indicated by northern arrow, historical, precise location unknown, potentially extirpated), 8) Tiddville and 9) Brier Island (indicated by southern arrow, presumed extirpated).

Extent of Occurrence and Area of Occupancy

Under COSEWIC guidelines (COSEWIC 2009b), extent of occurrence (EO) for extant plus extirpated sites is 4300 km^2. When considering extant and historical (but possibly extant) sites, the EO is approximately 3330 km^2. Excluding historical sites reduces extent of occurrence to 3000 km^2. Index of area of occupancy (IAO) derived using a 2 km x 2 km grid aligned with 10 km x 10 km UTM grid squares is 96 km^2 when limited to extant sites. IAO is 104 km^2 for extant and historical sites and 108 km^2 if the Brier Island population (presumed extirpated) is included as well.

HABITAT

Habitat Requirements

In the United States, Goldencrest is found mostly on wet acidic soils in bogs, pocosins (freshwater wetlands with deep sandy and peaty soils), wet savannahs, pine barrens and occasionally in nearby anthropogenically disturbed habitats such as roadside ditches (Robertson 2002).

Goldencrest habitat in Canada is typical of the suite of disjunct Atlantic Coastal Plain Flora of lakeshores, stream margins and peatlands, where low nutrient conditions and disturbances such as flooding, wave action and ice scour provide an advantage over more competitive, higher biomass species (Keddy and Wisheu 1989; Sweeney and Ogilvie 1993; Morris *et al.* 2002). The distribution of lakeshore Atlantic Coastal Plain communities is partly a function of catchment area, with lower watershed lakes more likely to support rich communities due to the presence of wider shorelines created by significant seasonal water level fluctuations (Hill and Keddy 1992; Hill *et al.* 1998; Morris *et al.* 2002). Suitable shoreline habitats are most often associated with broad windward shores where erosion from ice and wave scour help maintain infertile conditions by removing fine particles and nutrients from the soil (Keddy 1983, 1985).

In Nova Scotia, Goldencrest occurs primarily on larger lakes in open shoreline meadows with broad, exposed, low-gradient shores, in sheltered peatlands and floating peat mats. Substrates include pure peat, fine or coarse sand, gravel, cobble and rock outcrops. Based on observations at 23 lakeshore Goldencrest sites, Wisheu *et al.* (1994) classified occupied sites by substrate type (with some sites having combined substrate types), and noted that ~75% of sites had cobble substrate, ~55% had peat, >10% had sand, >10% had stone, ~10% had boulder and ~10% had gravel substrates. At Fancy and Shingle lakes, Goldencrest occurs in sheltered acidic bay bogs on quaking margins, floating peat mats and on seasonally exposed rocky islands with a thin peat layer.

Goldencrest is also known from open peatlands not associated with lakes, where it occurs in wet, open, nutrient-poor fen communities with high graminoid cover (Newell and Proulx 1998; Hill pers. comm. 2011), where it grows with a wide diversity of species. Most bog/fen occurrences are found in proximity to small watercourses or seasonally flooded depressions (Newell and Proulx 1998; Hill pers. comm. 2011), which likely plays a major role in maintaining suitable habitat.

Habitat Trends

Most remaining habitat in Canada is currently in relatively good condition with little anthropogenic disturbance. Historically, habitat has been extensively lost and degraded at Tiddville on Digby Neck, Brier Island (where the population is considered extirpated) and possibly at Fancy Lake. Shoreline cottage and residential development is having significant and ongoing impacts on habitats within portions of the two most extensive populations (Ponhook and Shingle lakes), but is not a significant threat elsewhere, as described in detail under *Threats and Limiting Factors*.

a) Historical Habitat Loss

In 1921, the Tiddville occurrence on Digby Neck was described as "...abundant, coloring the savannahs for two or three miles..." with "acres and acres [of Goldencrest] as far as the eye could see" (Fernald 1921). Fernald's Tiddville site has been severely degraded by diatomaceous earth mining, damming, ditching and use as a cow pasture (Newell and Proulx 1998), with Goldencrest reduced around the presumed original site in 1998 to about 16 flowering plants with 135 to 165 vegetative clumps (Newell and Proulx 1998; Newell 1999). However, the population near Tiddville has been found to extend 3.5 km further upstream in a series of smaller occurrences in minimally disturbed open peatlands (Newell and Proulx 1998) at which habitats and populations have been stable since 1998 (Blaney pers. obs. 2008; Proulx pers. comm. 2010).

The precise locality of the Brier Island occurrence is unknown, but was in a large open peatland along the island's southeast side. Goldencrest was last seen on the island by Keddy in 1985 (Keddy 1987) and no plants were found during recent surveys (Ogilvie and Zinck 1992; Newell and Proulx 1998; Swift pers. comm. 2008). Field observations indicate that partial draining and the establishment of a large gull colony at the site have resulted in the enrichment of wetland soils and the encroachment of shrubby and weedy vegetation (Newell 1999; COSEWIC 2010), which are believed to have resulted in the extirpation of Goldencrest at the site.

Habitat at Fancy Lake has likely been affected by the former Conquerall Mills power dam, which raised water levels by several metres between 1940 and the late 1970s. Goldencrest is currently restricted on the lake to a peatland at the head of a single bay and is absent from other apparently suitable habitats nearby, potentially as a result of historical flooding, as described in more detail under *Threats and Limiting Factors*. Habitats and populations have likely been stable at Fancy Lake over the past 15 years (three generations) and development potential within Goldencrest habitat is low, except perhaps at the margins of the occurrence, because of boggy conditions.

In the early 1920s, the damming of the upper Mersey River created the Lake Rossignol reservoir in Queens County and eliminated a significant amount of potential habitat. The reservoir covers roughly 150 km^2 and is the largest freshwater lake in Nova Scotia. The reservoir area once contained about ten more or less distinct water bodies, including several large lakes (Belliveau and Gray 2009). Because Goldencrest is known from areas northeast and southwest of the reservoir, it is plausible that sites historically supporting the species were lost due to this flooding.

b) Ongoing Habitat Impacts

At Ponhook Lake, Little Ponhook Lake and Shingle Lake, which support about 93% of known occurrences, shoreline alteration associated with cottage and residential development is significant. Using aerial photos, Nova Scotia Nature Trust (2002) found the number of structures (including buildings and docks) on Ponhook Lake had increased from eight in 1955 to eleven in 1965 to 230 in 2001. Many new structures have been added since then (Blaney and Mazerolle pers. obs. 2007-2010), with much of the development at these lakes occurring during the last 15 years (three generations). Most of the undeveloped private land around these lakes is owned by developers and/or already subdivided into lots. Numerous impacts are also added each year through new cottages and through additions and upgrades to existing properties.

Ponhook and Shingle lakes are large lakes with convoluted shores including many islands, and total proportion of altered shoreline on them is still low. In the Redroot status report (COSEWIC 2010), it was estimated that no more than about 6% of shoreline on Ponhook Lake and nearby lakes had been altered. Goldencrest co-occurs with Redroot on Ponhook, Little Ponhook and Bear Trap lakes, and it is unlikely that lakeshore alteration on Goldencrest lakes would exceed the 6% value, because Shingle and Seven Mile lakes are somewhat less developed than the lakes on which Redroot occurs.

As detailed under *Population Sizes and Trends*, Goldencrest habitat is not currently under significant threat at Seven Mile Lake or Dunraven Bogs because occurrences are on Crown land, nor at Tiddville and Fancy Lake because the sites are peatlands with limited appeal for cottage or residential development.

BIOLOGY

Little published information exists on the life history of Goldencrest and the reproductive biology and ecology of the species remain largely unknown. Though a substantial amount of research has been carried out on the morphology (Ambrose 1985; Simpson 1988) and phytochemistry (Zavada *et al.* 1983) of Goldencrest, this work has mostly focused on identifying the taxonomic affinity of the species. Given the persistent uncertainty associated with the familial affinities and because the genus is monotypic, general information cannot be readily gleaned from other species.

Life Cycle and Reproduction

Goldencrest is a rhizomatous and somewhat stoloniferous perennial herb. In its Canadian range, the species flowers from early August to early September (Keddy 1987; Zinck 1998; Blaney and Mazerolle pers. obs. 2007-2010) but it reportedly flowers much earlier further south (Robertson 2002).

Field observations suggest that reproduction in Canadian populations of Goldencrest is mainly vegetative by means of rhizomes and stolons (Keddy 1987; Newell 1999; Blaney and Mazerolle pers. obs. 2007-2010). Abundant flowering has been observed at some sites (Newell and Proulx 1998; Blaney and Mazerolle pers. obs. 2007-2010), but reproductive plants typically only represent a small fraction of populations and at some sites plants are entirely vegetative in a given year (Blaney and Mazerolle pers. obs. 2007- 2010). This may be due to climatic limitations, as flowering in Florida populations is reportedly abundant and consistent (Jenkins pers. comm. 2011; Johnson pers. comm. 2011). Seedlings have never been noted in the field (Keddy 1987; Newell 1999; Blaney and Mazerolle pers. obs. 2007-2010), but there has likely been limited effort to find them and the extent to which seed germination or seedling establishment are limiting is unclear. Low seed production, or even its absence, is known in several Atlantic Coastal Plain disjuncts in Canada (Keddy and Wisheu 1989; P.A. Keddy 1989; Sweeney and Ogilvie 1993; Vasseur 2005).

Nichols (1934) tested the effects on New Jersey Goldencrest seed of late autumn storage at low temperature. He found that seeds refrigerated for 71-112 days germinated in 42 to 84 days while untreated seeds required 90 days for germination. Trials by Newell and Proulx (1998) done indoors using field soils and seeds collected on Digby Neck found 20-45% germination within two months, suggesting that seed viability is not limiting in this population. Seed banking is not documented but is plausible given the fluctuating lakeshore habitat in which the species occurs. Seed banking is common in plants of fluctuating wetlands (*i.e.* Galinato and Van Der Valk 1986; Baskin and Baskin 1998; Bliss and Zelder 1998; Tuckett *et al.* 2010) and Keddy (1987) suggested that seedling recruitment might require significant water-level draw-downs.

Pollination biology is not documented, but the showy flowers suggest insect pollination, and the syrphid hoverfly *Syrphus ribesii* was observed on flowers in the Digby Neck area (Newell and Proulx 1998). It is not known whether Goldencrest is self-compatible.

Generation time of Goldencrest is estimated at 3-5 years based on field observations (Blaney and Mazerolle pers. obs. 2007-2010). Vegetatively derived rosettes likely require several years before they themselves are capable of reproducing vegetatively. Clonal clumps of Goldencrest appear to have the potential to be very long lived, on the scale of decades (Blaney and Mazerolle pers. obs. 2007-2010), but the longevity and time required for individual rosettes (the units corresponding to COSEWIC "mature individuals") to reach vegetative or sexual reproduction in the field is unknown. Virginia Proulx (pers. comm. 2011) reports that Goldencrest cultivated from seed indoors began rhizome formation at 2 years but never flowered over 6 years.

Physiology and Adaptability

Goldencrest is part of Nova Scotia's Atlantic Coastal Plain flora, a group of stress-tolerant species adapted to nutrient-poor conditions and able to withstand periodic flooding, wave action and ice scouring (Keddy and Wisheu 1989; Sweeney and Ogilvie 1993; Wisheu *et al.* 1994). No relevant information on physiology was found during the preparation of this report.

Dispersal and Migration

The apparently limited seedling recruitment observed in Canadian populations (Newell and Proulx 1998; Keddy 1987; Blaney and Mazerolle pers. obs. 2007-2010) could indicate that dispersal potential in Canada is lower than in southern parts of Goldencrest's range, as could the species' frequent absence from apparently suitable habitat within its Canadian range, including areas immediately adjacent to occupied sites.

Though the species shows no adaptation to wind dispersal, small seed size (1-1.5 x 0.5 mm) and the fact that stems remain erect during capsule dehiscence suggest that strong winds could carry seeds over moderate distances away from parent plants, especially over ice in winter. Because most Goldencrest populations in Canada occur in association with water bodies or watercourses, hydrochory (dispersal by water) could allow long-distance dispersal across water bodies and downstream along river systems. The buoyancy and flotation period of Goldencrest seeds have not been investigated. Goldencrest does not exhibit adaptations for zoochory (animal-mediated dispersal), such as fleshy fruits or fruits/seeds bearing stiff hairs, but seeds could be dispersed over longer distances by becoming lodged in fur or feathers of animals brushing against seed-dispersing plants. The transfer of seeds or individuals upstream within watersheds is less likely and would probably be largely dependent on animal-mediated dispersal. Seeds could be carried by animals over the 3.5 km separating the Shingle Lake (Medway watershed) and Seven Mile Lake populations (LaHave watershed), although this would presumably be very infrequent. Fallen seeds could also be carried in mud clinging to animals passing through populations.

Goldencrest disperses vegetatively over short distances through rhizome or stolon growth, allowing individuals to colonize adjacent suitable habitat. Rhizomes or entire plants could also be transported individually or in clumps of peat dislodged by wave action or ice scour and thus be carried over some distance across water bodies and downstream along rivers.

Given the presumed dispersal potential of the species, exchange between any other populations in different watersheds seems likely to be even less frequent.

Interspecific Interactions

Like several other members of the coastal plain flora in Canada, Goldencrest is a stress-tolerant plant with a low competitive ability (Wisheu and Keddy 1989; Wisheu *et al.* 1994). It is typically found where natural water level fluctuations and low nutrient availability prevent the long-term establishment of more competitive vegetation. In an experiment investigating the competitive response of a number of wetland plants, the mean biomass of Goldencrest individuals grown alone was found to be more than double that of plants grown with other species (Keddy *et al.* 1998). Habitat alterations that increase nutrient availability and/or suppress natural water level fluctuations can lead to habitat encroachment by faster-growing competitive species, resulting in habitat loss and local extinctions (P.A. Keddy 1989; Wisheu and Keddy 1994). This effect is implicated in the presumed extirpation of the Brier Island population where peatland habitat has become dominated by tall herbs and shrubs after drainage and enrichment by nesting gulls (COSEWIC 2010).

Besides pollination by *Syrphus ribesii*, Newell and Proulx (1998) also noted that a small number of plants had been browsed at one site near Tiddville, perhaps by a deer or muskrat.

POPULATION SIZES AND TRENDS

Search Effort

The presence of Atlantic Coastal Plain flora in southern Nova Scotia has been well known since Fernald's expeditions (Fernald 1921, 1922). Extensive floristic work focused on the coastal plain flora in southern Nova Scotia has since been undertaken, starting in the 1950s to the 1970s by Chalmers Smith and students, and by Albert Roland and John and David Erskine (as documented in Roland and Smith 1969). Paul and Cathy Keddy, Irene Wisheu, Nicholas Hill and their collaborators conducted detailed studies on the ecology, distribution and local diversity of Nova Scotian coastal plain flora with a focus on conservation implications (P.A. Keddy 1984, 1989; C.J. Keddy 1989; Keddy and Wisheu 1989; Wisheu and Keddy 1991; Hill and Keddy 1992; Wisheu and Keddy 1994; Wisheu *et al.* 1994; Holt *et al.* 1995; Morris *et al.* 2002). More recently, floristic and conservation work has been conducted by Atlantic Canada Conservation Data Centre (AC CDC), Nova Scotia Department of Natural Resources, Nova Scotia Nature Trust and Mersey Tobeatic Research Institute (MTRI) (*e.g.* Eaton and Boates 2003; Blaney 2002, 2004, 2005a, b; MTRI 2010a), among others. Of particular relevance to Goldencrest is work by AC CDC from 2007 to 2010 (Blaney and Mazerolle 2009, 2011) that involved visits to 40 lakes within 40 km of Ponhook Lake, with complete shoreline surveys of most lakes. Only one new site for Goldencrest (Seven Mile Lake) was found, demonstrating the species' rarity.

In all, there have probably been 200+ field days since 1960 spent around lakeshores in Goldencrest's potential range by botanists capable of identifying vegetative plants. Search effort is certainly sufficient to say that the species is very rare within the coastal plain zone of Nova Scotia and is not likely present in the coastal plain hotspots on the lakes of the lower Tusket River system in the extreme southwest of Nova Scotia. Despite these efforts, there are still many lakes around the Ponhook-Molega region and in more remote areas southward that have seen little or no botanical survey and additional populations could be found, especially because small, vegetative populations of the species could be very cryptic. However, few of the less-surveyed lakes have the combination of characteristics (unregulated water levels, large size and low position in their watersheds) identified as being most associated with rare coastal plain species in Nova Scotia (Hill and Keddy 1992).

Search effort in the Brier Island-Digby Neck region is more complete. Suitable habitat there is fairly limited and virtually all of it from Tiddville south has been surveyed (Ogilvie and Zinck 1992; Newell and Proulx 1998; Swift pers. comm. 2008; Proulx pers. comm. 2010) during 2008 fieldwork for the Eastern Mountain Avens (*Geum peckii*) COSEWIC status report (COSEWIC 2010). No attempts to relocate the historical locality from Sandy Cove, slightly north of this area, are documented, but there are only a few, small potentially suitable sites, so it is unlikely that any undiscovered populations would significantly change the overall status of the species.

The Goldencrest occurrence at Dunraven Bog is within a very large, remote peatland and many similar, large peatlands between the Ponhook Lake area and the southern tip of Nova Scotia have never been visited by botanists. The type of wet, graminoid-dominated fen in which Goldencrest is most likely to occur is not always present in a particular peatland, but there are undoubtedly many such sites that have not been surveyed. The species is clearly rare even within ideal fen habitat. Fieldwork for this status report (Blaney and Mazerolle pers. obs. 2010) included visits to potentially suitable large peatlands with ideal graminoid fen habitats near Caduesky, Little Rocky, Smith and Broad River lakes, and several other similar sites have been visited by AC CDC in previous fieldwork with no new Goldencrest sites found until a single new location in a peatland just north of Shingle Lake was discovered in 2011 (Blaney 2011).

Defining Populations and Locations

Populations are defined in this report using standards in NatureServe (2004), under which occurrences meeting one of the following conditions are grouped into a single population: 1) occurrences separated by less than 1 km, 2) occurrences separated by 1 to 3 km with no break in suitable habitat between them exceeding 1 km, 3) occurrences separated by 3 to 10 km but connected by linear water flow with no break in suitable habitat between them exceeding 3 km. Under these standards, nine Goldencrest populations have been found in Canada (Table 1): 1) Ponhook Lake (including Bear Trap and Little Ponhook lakes), 2) Hog Lake, 3) Shingle Lake, 4) Seven Mile Lake, 5) Fancy Lake, 6) Dunraven Bog, 7) Sandy Cove (considered historical), 8) Tiddville and 9) Brier Island (considered extirpated) (Figures 4 and 5).

Table 1. Number of locations and individuals recorded at each population site, with land ownership. Information from AC CDC (2011).

Population	Watershed	Number of locations	Number of individuals	Land ownership
1. Ponhook Lake (incl. Bear Trap & Little Ponhook lakes)	Medway	~32	likely 100 000+	~31 properties, ~35 sites on Crown land (one location)
2. Hog Lake	Medway	2	~35	Both on private land (2 properties)
3. Shingle Lake	Medway	37	likely 100 000+	Locations on private land (~36 properties), ~20 sites on Crown land (one location)
4. Seven Mile Lake	LaHave	1	~215	All sites on Crown land
5. Fancy Lake	Petite Rivière	3 (+1 historical)	100 000+	3 recent locations are on private land (3 properties), unknown historical location (E side Fancy Lake) likely on private land, if directions accurate
6. Dunraven Bog	Mersey	1	1000s	Crown land
7. Sandy Cove (historical)	Unknown	Unknown	Unknown	Precise locality unknown but all land in the area is privately owned. Not seen since 1949.
8. Tiddville Bogs	Little River	1	Unknown (2750 flowering stems)	All sites are on private land (3 properties)
9. Brier Island (presumed extirpated)	-	-	-	Historical occurrence on private land (1-3 properties). Not seen since 1985.

* Estimated based on recorded numbers of flowering stems times flowering plant to vegetative plant ratios seen at other Canadian locations.

For the purposes of COSEWIC assessment, locations are defined by the scale of the most immediate threat to the species (COSEWIC 2009b). Shoreline alterations associated with residential and recreational development are the most immediate threat to Goldencrest in Canada, because development currently occurs on several Goldencrest lakes, and other identified threats are not known to currently impact Goldencrest to any significant extent. The scale of impact of this threat could be considered equivalent to the scale of property subdivision, in which case the number of COSEWIC locations would be a minimum of 75 (the number of separate parcels of private land on which the species occurs plus one location per lake for unthreatened occurrences on Crown land). Occurrences facing minimal threat (non-lakeshore peatland sites or Crown land lakeshore sites) within a particular population are lumped into a single location per population. Older, imprecise localities and unsurveyed areas on Shingle and Ponhook lakes make an exact count at this scale difficult. In either case, number of locations is well over the 10 location threshold under COSEWIC's B criterion (COSEWIC 2009b).

Abundance

COSEWIC criteria refer to "mature individuals", and for a clonal plant this refers to any unit capable of surviving on its own and reproducing. A Goldencrest rosette capable of vegetative or sexual reproduction is thus a mature individual for the purposes of this report. Goldencrest often occurs in fairly dense stands of hundreds or thousands of rosettes, each therefore is considered to be a mature individual that are difficult to count and which likely represent a very small number of genetic individuals.

Goldencrest is presently known to occur at approximately 75 locations in seven extant populations, with numbers of individuals in the hundreds of thousands (Table 1). Most Canadian populations are concentrated in a relatively small region near the Lunenburg-Queens County border. Sites with the largest populations are Ponhook Lake, Shingle Lake, Fancy Lake and Tiddville.

Lunenburg County and Queens County region of occurrence

Lunenburg and Queens counties constitute the main region of occurrence in Canada, including six of the seven extant populations, nearly 95% of occurrences and more than 95% of the Canadian population.

The Ponhook Lake population (including the single occurrence at Bear Trap Lake and occurrences at Little Ponhook Lake) is the most extensive Canadian population, and includes approximately 32 locations spread over an 8.5 km x 4.7 km area. Based on visual estimates combined with local counts, the total number of individuals on the lake likely exceeds 100 000 but the population is not precisely known. Most occurrences in this population are small patches with numbers of individuals in the tens to low thousands, but the lake also supports several extensive colonies with large numbers of individuals that are difficult to count. Despite the 30+ botanist days spent on the lake by C.J. Keddy (1989), MacKinnon (1998) and more recently the AC CDC (Blaney and

Mazerolle 2009, 2011) and Mersey Tobeatic Research Institute (2010a), distribution on the lake's 150+ km of shoreline is not completely documented.

Hog Lake has been comprehensively surveyed and it supports a very small population of two locations with approximately 35 individuals counted in 2010. One occurrence with fewer than ten flowering stems was discovered by MacKinnon (1998). That occurrence was not relocated in 2010, despite searching of the site, but three additional occurrences were found.

Shingle Lake supports an extensive population in 37 documented locations over 6.7 km x 2.3 km. There are many thousands of individuals in this population, probably more than 100 000 (based on visual estimates combined with local counts), with abundant flowering, but detailed counts of rosettes have not been undertaken.

The Seven Mile Lake population was discovered by the AC CDC in 2008. Suitable habitat was almost entirely surveyed, except for a peatland in the northeast corner. The roughly 215 individuals were restricted to 0.5 km of shoreline at one corner of the. The sites are considered a single location because all are on Crown land and therefore relatively unthreatened.

Fancy Lake supports a large, dense population visually estimated in the hundreds of thousands of individuals in 2010. All plants were within a 250 m radius in a single bay and they occur on three separate private properties and on Crown land, representing four locations. At this site, Goldencrest is locally dominant on floating peat mats and is abundant over one or two hectares of shoreline bog. The species does not seem to be present anywhere else in the 5 km long lake, and a 1953 record from "east side of Fancy Lake" has either disappeared, is very small and inconspicuous, or (perhaps most likely) was a labelling error.

The Dunraven Bog population was discovered in 1990 and has not been revisited since its discovery. Goldencrest was found at a single site and noted to be locally abundant (thousands of individuals) over an area at least 150 m in length (Hill pers. comm. 2011).

Digby County region of occurrence

This region of occurrence supports one extant, one presumed extirpated and one historical population and likely includes less than 10% of the total Canadian population.

The extant population on Digby Neck is considered a single population and includes roughly 12 patches scattered over a 3.5 km-long area in open wetlands between Tiddville and East Ferry, with two adjacent patches that occupy under 0.1 ha supporting 80% of flowering stems. Newell and Proulx (1998) counted 2750 flowering stems at all Tiddville area sites, but it is unclear how this translates to "mature individuals" as defined by COSEWIC.

A population was discovered near Sandy Cove in 1949 (Pronych and Wilson 1993). The exact locality has never been identified and it is not known if the occurrence is extant. Suitable habitat is limited but aerial photography (Google Earth 2011) shows several wetlands with open habitats nearby. The most likely site has been altered, perhaps to enhance duck habitat.

Fluctuations and Trends

There is no evidence in the published literature or from observations of the Canadian population that would suggest that Goldencrest is prone to significant year to year fluctuations in population sizes.

Available survey data are insufficient for direct assessment of fluctuations or long-term trends in abundance because of lack of repeat surveys, locational uncertainty of older records and inconsistencies in the way plant numbers have been recorded. However numerous sites have persisted from 1986 and 1998 to the present on Ponhook, Little Ponhook and Hog lakes (Blaney and Mazerolle pers. obs. 2007-2010) and the Fancy Lake population first discovered by Fernald in 1920 is also still extant.

The Tiddville population on Digby Neck, which suffered major declines from 1920 levels due to extensive diatomaceous earth mining, damming, watercourse alteration and use as cow pasture (Newell and Proulx 1998), is now almost completely restricted to relatively undisturbed peatlands where repeated counts have documented stable populations since 1998 (Proulx pers. comm. 2010).

The Brier Island population was considered probably extirpated in the previous status report (Newell 1999) and 2008 surveys for Eastern Mountain Avens at the site (Swift pers. comm. 2008, and surveys for COSEWIC 2010) also failed to find it.

As a result of increased survey effort, the number of known sites in the Ponhook and Shingle lake populations has increased substantially since the last update status report (Newell 1999). However, population sizes have likely decreased slightly (by less than 6%, see *Population Sizes and Trends*) as a result of waterfront cottage and residential development.

Extant populations at Hog Lake, Seven Mile Lake, Fancy Lake, and Dunraven Bog have not experienced major habitat changes in the past 15 years (3-5 generations) and therefore likely have stable populations.

The overall population trend for Canada over the past 15 years (3-5 generations) is thus likely a minor decline of less than 6%.

Rescue Effect

The 800+km disjunction across the open Atlantic Ocean, between Canadian sites and the next nearest populations in New Jersey, means that there is a negligible chance of any rescue effect from occurrences in the United States.

THREATS AND LIMITING FACTORS

Shoreline Development

Shoreline development is the most serious threat to Goldencrest populations, as is true of most rare Atlantic Coastal Plain species in Canada (Environment Canada and Parks Canada Agency 2010). There are dozens of cottages having Goldencrest on their properties on Ponhook, Little Ponhook and Shingle lakes and their shorelines may be altered by infilling or hardening of shorelines, dumping of sand or gravel, removal of boulders and rocks for beaches or boat launches, construction of docks, dredging of boat slips and manicuring of shoreline vegetation. Large portions of the undeveloped shoreline on Ponhook and Shingle lakes owned by developers and/or already subdivided continue to be under significant development pressure (see *Habitat Trends*).

Shoreline development may have reduced the distribution of Goldencrest at Little Ponhook Lake as comprehensive lakeshore surveys in 2010 failed to find at least two of Keddy's (1987) occurrences within a heavily developed zone. Further shoreline development on Little Ponhook Lake could readily impact the small numbers there as occurrences are on good shoreline for cottage development and have good road access.

The wide zone of wet peatland along the lakeshore at Fancy Lake makes it less attractive for cottage or residential development and prevents building of infrastructure directly on plants, reducing the direct and immediate threat there. Shoreline development continues on Bear Trap and Seven Mile lakes, but the known sites on those lakes are on Crown land, with limited threats because no new Crown land camp leases are being granted (MacKinnon pers. comm. 2011; d'Eon pers. comm. 2011). Cottage or residential development is not a threat at Dunraven Bog, a remote Crown land site in the middle of a very large peatland, or at the peatland sites on Digby Neck near Tiddville.

Blaney and Mazerolle (pers. obs. 2007-2010) suggest that shoreline development impacts on Goldencrest are likely slightly less severe than is the case with Redroot (COSEWIC 2009a) because Goldencrest is somewhat more restricted to wetter and more peaty substrates that are less attractive for beach use. The level of threat may increase in the future as prime undeveloped beach sites become scarcer and development moves further into other lakeshore types. Impacts of shoreline development vary by property from nearly complete destruction of natural habitat to very minimal impact. Most commonly, cottagers use a portion of their shorefront intensively for docks, boat launches, patios or swimming areas, that impact or destroy that part of the population, but the remaining shorefront is used less intensively in ways that could allow persistence of plants. In most cases there are also relatively undisturbed portions of shoreline between adjacent cottages. Impacts of shoreline alteration are not limited to newly constructed cottages. Existing development sites continue to add "improvements" over time and Blaney and Mazerolle (pers. obs. 2007-2010) observed numerous instances of long-established cottages having further altered their shorelines in the recent past through infilling or hardening of shorelines, removing boulders or vegetation and construction of various structures.

As noted under *Habitat Trends*, the total percentage of highly altered shoreline is still low (estimated 6% or less). The threat of shoreline development is also mitigated because about 5% of the Ponhook Lake shoreline, which includes 24% of Ponhook Lake Goldencrest sites, is now within a provincial nature reserve and 25% of sites on Shingle Lake are on Crown land not susceptible to development. However, 100% of suitable habitat on Little Ponhook Lake and 95% on Ponhook Lake is privately owned. About 50% of habitat and 80+% of individuals are on private land on Shingle Lake. New development and intensification of existing development is thus likely to continue to cause slow decline in populations and habitat quality through the foreseeable future on these lakes, though new shoreline development within the next 10 years at all sites will likely be much less than existing development.

Artificial Regulation of Water Levels

Water level fluctuations are a major determinant of the vegetation of shoreline habitats. The artificial regulation of water levels through dam construction can directly eliminate shoreline species through flooding and alter community composition as the loss of natural fluctuations allows for the dominance of shrubs and other competitive, high biomass species over less competitive species like Goldencrest (P.A. Keddy 1989; Wisheu and Keddy 1994; Nilsson and Jansson 1995; Hill *et al.* 1998; Merritt and Cooper 2000). Dam construction is widely recognized as a major threat to coastal plain shoreline flora (Keddy and Reznicek 1982; Wisheu and Keddy 1994; Hill *et al.* 1998; Environment Canada and Parks Canada Agency 2010) and has extirpated several populations of rare coastal plain species in Nova Scotia (Keddy 1985). On Brier Island and Digby Neck, damming and watercourse alteration are implicated in significant habitat loss and population declines for Goldencrest (Keddy 1987; Newell and Proulx 1998; Newell 1999).

No Goldencrest lakes are currently controlled by downstream dams, but Fancy Lake had a power dam at Conquerall Mills built c.1940 and breached in the late 1970s which would have raised water level several metres. The Goldencrest population was probably able to persist there because of occurrence on floating peat mats, and the exceptional abundance in shoreline peatland at that site could be due to competitive release in formerly flooded peatland following dam breaching. The absence of Goldencrest in nearby bays with apparently suitable peatland could be explained by the absence of large, floating peat mats that would have allowed the species to survive flooding in those sites.

In the early 1920s, the creation of the Lake Rossignol reservoir in Queens County eliminated a significant amount of potential habitat. The reservoir area (150 km^2) once contained about ten more or less distinct water bodies, including several large lakes (Belliveau and Gray 2009). Because Goldencrest is known from areas to the northeast and to the southwest of the reservoir, it is plausible that sites historically supporting the species were lost due to flooding.

Eutrophication

Eutrophication from residential and agricultural sources can have a detrimental impact on Atlantic Coastal Plain communities (Ehrenfeld 1983; Zaremba and Lamont 1993) and is considered an important threat to coastal plain species in Nova Scotia (Environment Canada and Parks Canada Agency 2010). Impacts of eutrophication have thus far been observed primarily outside Goldencrest range in the region near Yarmouth where effluent from mink farming and fish processing sites has dramatically altered water quality and appears to have increased common, competitively dominant shoreline and aquatic plant species (Mersey Tobeatic Research Institute 2010b).

Like most of the rare coastal plain flora in Canada, Goldencrest is restricted to nutrient-poor habitats and is generally unable to tolerate competition for light and nutrients from larger and faster growing plants (Wisheu and Keddy 1989) so extreme eutrophication would likely have a negative impact. Agriculture is limited near occurrences in Queens and Lunenburg counties but significant residential and cottage development may be increasing nutrient availability at Ponhook and Fancy lakes and to a lesser extent at Seven Mile and Shingle lakes. Though no signs of eutrophication have been observed, further development at these sites could add to cumulative nutrient loading and eventually lead to habitat degradation.

On Brier Island, nutrient enrichment following establishment of a large gull colony has encouraged the encroachment of weedy species and woody shrubs into Goldencrest habitat and resulted in the presumed extirpation of the island's population.

Off-road Vehicle Traffic

Off-road vehicle (ORV) traffic is considered a threat to several coastal plain flora species in Nova Scotia (Wisheu and Keddy 1994; Environment Canada and Parks Canada Agency 2010). The slow growth rates of many coastal plain species make lakeshore coastal plain communities particularly vulnerable to disturbance (Sharp and Keddy 1985; Keddy and Wisheu 1989). Even infrequent vehicle traffic can have a significant impact on these communities, allowing common ruderal species to colonize areas once occupied by rare species (Keddy and Wisheu 1989). Keddy *et al.* (1989) also observed that the soils of heavily damaged sites held fewer viable seeds. At present, this threat is only theoretical. ORV tracks are occasionally present in lakeshore sites, but Blaney and Mazerolle (pers. obs. 2007-2010) have observed no significant damage to Goldencrest plants. Many lakeshore Goldencrest occurrences are on islands or shores too narrow and rocky for ORVs. Goldencrest occurrences in bogs, especially those with small numbers and area occupied, may be more susceptible to ORVs, as heavily used ORV trails can significantly impact peatlands and such trails are easily seen on air photos in many southwest Nova Scotia peatlands, even in very remote areas (Google Earth 2011). ORV trails found by Newell and Proulx (1998) at several Goldencrest occurrences on Digby Neck were mostly limited to late fall and winter when impact on Goldencrest is likely to be minimal. Proulx (pers. comm. 2010) reports that the local people who most frequently used these trails in 1998 no longer use ORVs.

Invasive Species

Glossy Buckthorn (*Frangula alnus*), a highly invasive, bird-dispersed shrub well adapted to wet, acidic habitats, is now common and rapidly expanding in southwestern Nova Scotia (Blaney and Mazerolle pers. obs. 2010). It may have difficulty establishing dense populations on lakeshore habitats used by Goldencrest but could be a near future threat in peatland sites such as Dunraven Bog and Tiddville or in lake-associated peatlands on Ponhook, Shingle and Fancy lakes. This bird-dispersed species is not yet documented within Goldencrest occurrences but is abundant near Digby (37 km from Tiddville) and is likely already in the vicinity of Tiddville. It is also widespread and locally abundant in the Ponhook and Shingle lakes areas where it is known within 1 km of some Goldencrest occurrences. Dense populations of Glossy Buckthorn would almost certainly be problematic for Goldencrest, which is known in Nova Scotia exclusively from sites completely lacking extensive tall shrub or tree cover. Even the most remote locations are not immune from Glossy Buckthorn because of bird dispersal. Yet Glossy Buckthorn has not become abundant in the types of peatlands in which Goldencrest might be found and the habitat may not be suitable for Glossy Buckthorn to dominate.

No other exotic species likely to alter Goldencrest habitat have yet been observed close to populations. Coastal plain habitats in Nova Scotia are generally inhospitable to exotic plants (Eaton and Boates 2003), but eutrophication and water level stabilization can make sites more susceptible to invasion (Wisheu and Keddy 1994; Hill *et al.* 1998; Environment Canada and Parks Canada Agency 2010) by exotics or by common, highly competitive native species like Canada Bluejoint (*Calamagrostis canadensis*). This could be a future threat with increased lakeshore development (Hobbs and Huennecke 1992; Mack *et al.* 2000) and eutrophication.

Substrate Removal

The harvesting of peat or diatomaceous earth involves the removal of vegetation and soil horizons and can therefore result in complete habitat loss and local extinctions. The mining of diatomaceous earth on Digby Neck during the first half of the 20th century resulted in significant habitat loss and population declines (Keddy 1987; Newell 1999). Peat mining has also been raised as a potential threat to the Dunraven Bog population site (Newell 1999), but any large scale projects involving substrate removal at Goldencrest population sites would likely be precluded by the *Nova Scotia Endangered Species Act*. Smaller scale non-industrial harvesting could, however, easily go unnoticed and have a substantial impact on populations.

PROTECTION, STATUS, AND RANKS

Legal Protection and Status

In Canada, Goldencrest was originally assessed as Threatened by COSEWIC in 1987. Its status was reassessed and upheld in May 2000. The species is currently listed as Threatened and included on *Schedule 1* of the federal *Species at Risk Act* (Government of Canada 2011). It is listed as Threatened under the *Nova Scotia Endangered Species Act* (Nova Scotia Department of Natural Resources 2011). Legislation under the provincial act prohibits the disturbance or destruction of plants or their habitat on all lands. Goldencrest is also Endangered in North Carolina (NC NHP 2010).

Non-Legal Status and Ranks

In 1994, Goldencrest was globally assessed as Apparently Secure (G4; NatureServe 2011). In the United States, which includes most of the species' global range, it is also considered Apparently Secure (N4?; NatureServe 2011). In Canada, it is ranked as Imperilled (N2) by NatureServe Canada and has a General Status rank of At Risk. In Nova Scotia, it has a NatureServe subnational status rank of Imperilled (S2) and a General Status rank of At Risk, which equates to a "Red" designation under the Nova Scotia Department of Natural Resources' provincial ranks.

In the United States, it is rare or extirpated in five of the seven states where it occurs. State-level status ranks are: Alabama (S3S4), Delaware (SX; extirpated), Georgia (S1?), North Carolina (S2), Louisiana (S2S3), Mississippi (S4?), New Jersey (S4) and Florida (SNR; indicating it has not yet been ranked, likely because it is considered secure; NatureServe 2011).

In 2010, a recovery strategy and management plan for multiple species of the Atlantic Coastal Plain, including Goldencrest, was developed (Environment Canada and Parks Canada Agency 2010).

Habitat Protection and Ownership

Only approximately 30% of Canadian sites (occurrences separated by 10m or more) are on Crown land (Table 1), and this total would likely be lower if all occurrences on private land on Ponhook and Shingle lakes were documented. There are a minimum of 75 separate private properties with known Goldencrest occurrences and they represent well over 75% of the total recorded Canadian population.

About 25% the Ponhook Lake occurrences are on Crown land within Ponhook Lake Nature Reserve (39 small shoreline and island parcels totalling 43 hectares on Ponhook, Little Ponhook, Molega, Bear Trap, Cameron and Hog lakes; MacKinnon pers. comm. 2011), granting them protection under the provincial *Special Places Protection Act*. Many privately owned sites supporting Goldencrest occurrences in the Ponhook Lake area have been identified by the province of Nova Scotia as "Sites of Ecological Significance". This designation does not confer legal protection but identifies sites of interest for future conservation efforts (purchase, easements, etc.).

At Shingle Lake, over 75% of occurrences appear to be on private land, although many of the largest concentrations of individuals at this site are found in wide meadows, shoreline bogs, small islands and floating peat mats that are not marked as land in GIS, are not clearly included within private property boundaries and are likely Crown land (although they may not always be perceived as such by adjacent private landowners).

All recorded occurrences in the Hog Lake, Fancy Lake and Tiddville Bogs populations are on private land while the Dunraven Bog and Seven Mile Lake populations are fully on Crown land.

The lakeshore and peatland habitat of Goldencrest receives indirect protection from provincial laws and policies regulating shoreline development and pertaining to the protection of water quality, watercourses, wetlands and riparian buffers. These include the *Activities Designation Regulations* and *Environmental Assessment Regulations* under the *Environment Act*, the *Forest Act*'s *Wildlife Habitat and Watercourses Protection Regulations*, the *Off Highway Vehicle Act* and the *Forest Act*'s *Wildlife Habitat and Watercourses Protection Regulations*. Though projects involving lakeshore or wetland alterations are generally required to go through an assessment and permitting process, not all private landowners make efforts to acquire necessary permits and enforcement is limited.

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BIOGRAPHICAL SUMMARY OF REPORT WRITER(S)

David Mazerolle completed an undergraduate degree with a major in biology and a minor in geography, followed by a Master's degree in environmental studies, both at the Université de Moncton. For his M.Sc. he studied the geography of exotic vegetation in Kouchibouguac National Park and created a strategy for the management of the park's exotic invasive flora. David has worked as a botanist at the Atlantic Canada Conservation Data Centre (AC CDC) since 2007. Prior to this he was coordinator for rare plant survey and monitoring projects at the Bouctouche Dune Irving Eco-Centre from 2003 to 2006, where his work focused on the rare coastal plants of New Brunswick's Northumberland Coast. He has over ten years' experience working on various research, survey and monitoring projects and has authored and coauthored numerous status reports and technical reports pertaining to rare plants in Atlantic Canada.

Sean Blaney is the Botanist and Assistant Director of the Atlantic Canada Conservation Data Centre, where he is responsible for maintaining status ranks and a rare plant occurrence database for plants in the three Maritime provinces. Since beginning with the AC CDC in 1999, he has discovered dozens of new provincial records for vascular plants and documented thousands of rare plant locations during extensive fieldwork across the Maritimes region. Sean is a member of the COSEWIC Vascular Plant Species Specialist Committee, the Nova Scotia Atlantic Coastal Plain Flora Recovery Team, and has co-authored numerous COSEWIC and provincial status reports. Prior to employment with AC CDC, Sean received a B.Sc. in Biology (Botany Minor) from the University of Guelph and an M.Sc. in Plant Ecology from the University of Toronto, and worked on a number of biological inventory projects in Ontario as well as spending eight summers as a naturalist in Algonquin Park, where he co-authored the second edition of the park's plant checklist.

COLLECTIONS EXAMINED

All known Nova Scotia specimens were already documented in the Atlantic Canada Conservation Data Centre database (AC CDC 2010) prior to the preparation of this report, so no further examination of herbarium specimens was undertaken.

Appendix 1. In Canada, Goldencrest on lakeshores grows in association with:

Twig-rush (*Cladium mariscoides*),
Cord-Grass (*Spartina pectinata*),
Spoon-leaved Sundew (*Drosera intermedia*),
Sweet Gale (*Myrica gale*),
Canada Rush (*Juncus canadensis*),
Bog Aster (*Oclemena nemoralis*),
Royal Fern (*Osmunda regalis* var. *spectabilis*),
Brown Beakrush (*Rhynchospora fusca*),
Large Cranberry (*Vaccinium macrocarpon*),
Rose Pogonia (*Pogonia ophioglossoides*),
Redtop Panic Grass (*Panicum rigidulum* var. *pubescens*),
Switch Grass (*Panicum virgatum* var. *spissum*),
Carolina Grass-leaved Goldenrod (*Euthamia caroliniana*),
Yellow-eyed Grass (*Xyris difformis*),
Virginia Meadow-beauty (*Rhexia virginica*),
Eaton's Witchgrass (*Dichanthelium spretum*),
Golden Pert (*Gratiola aurea*),
Southern Bog-Clubmoss (*Lycopodiella appressa*),
Redroot (*Lachnanthes caroliniana*),
Long's Bulrush (*Scirpus longii*)
Tufted Leafless-Bulrush (*Trichophorum caespitosum*),
Coast Sedge (*Carex exilis*),
Slender Sedge (*Carex lasiocarpa*),
Northern Beaked Sedge (*Carex utriculata*),
Pickering's Reed Bent-grass (*Calamagrostis pickeringii*),
White Beakrush (*Rhynchospora alba*),
Leatherleaf (*Chamaedaphne calyculata*),
Bog Bean (*Menyanthes trifoliata*),
Shrubby Cinquefoil (*Dasiphora fruticosa* ssp. *floribunda*).